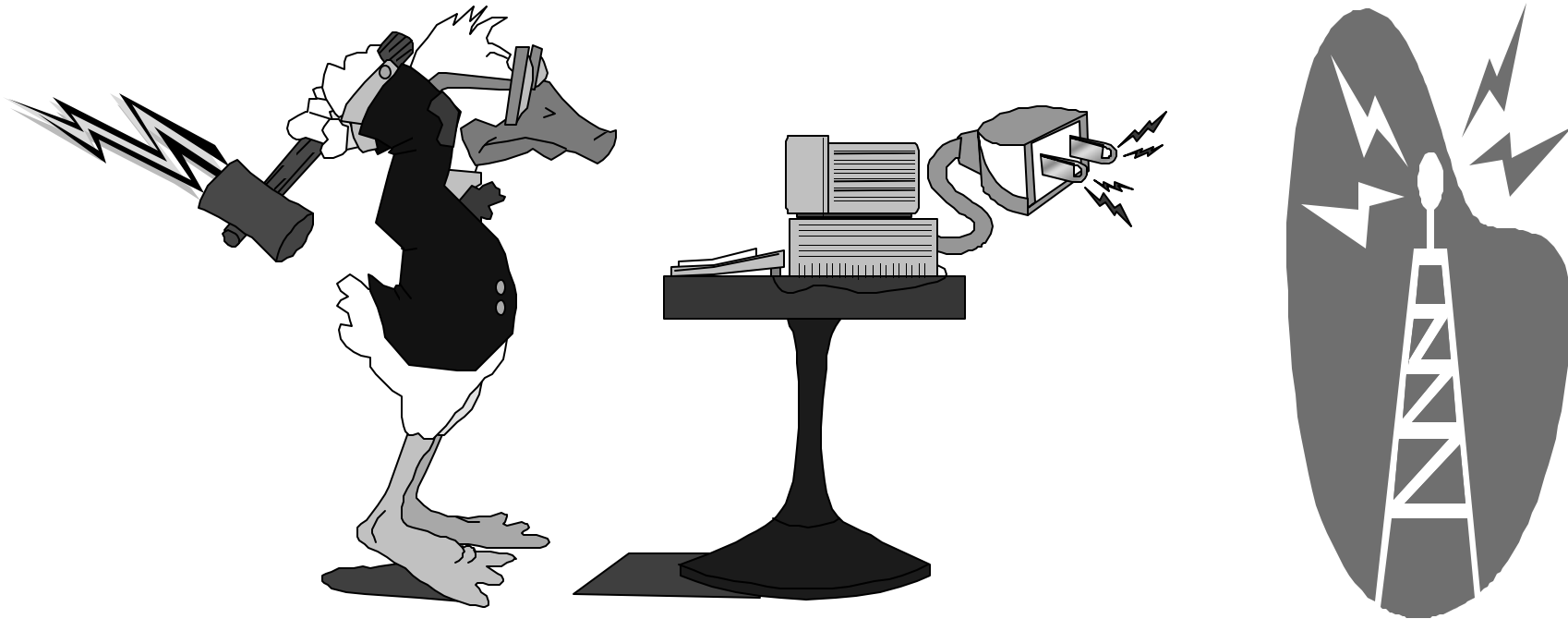


# Electro Magnetic Compliance



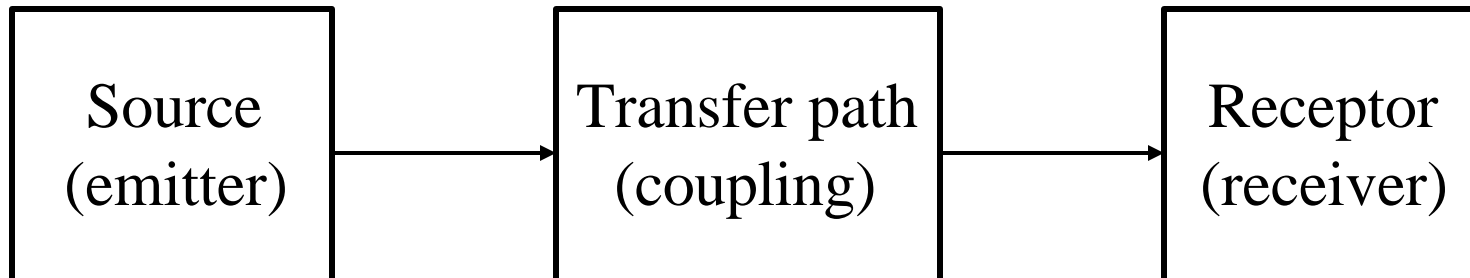
# Overview of EMC

- **EMC- Electromagnetic Compatibility**
  - Capability of an electronic system to function compatibly with other electronic systems and not produce or be susceptible to interference
  - A system is electromagnetically compatible if:
    - It does not cause interference with other systems
    - It is not susceptible to emissions from other systems
    - It does not cause interference with itself

# EMC Vs EMI or RFI

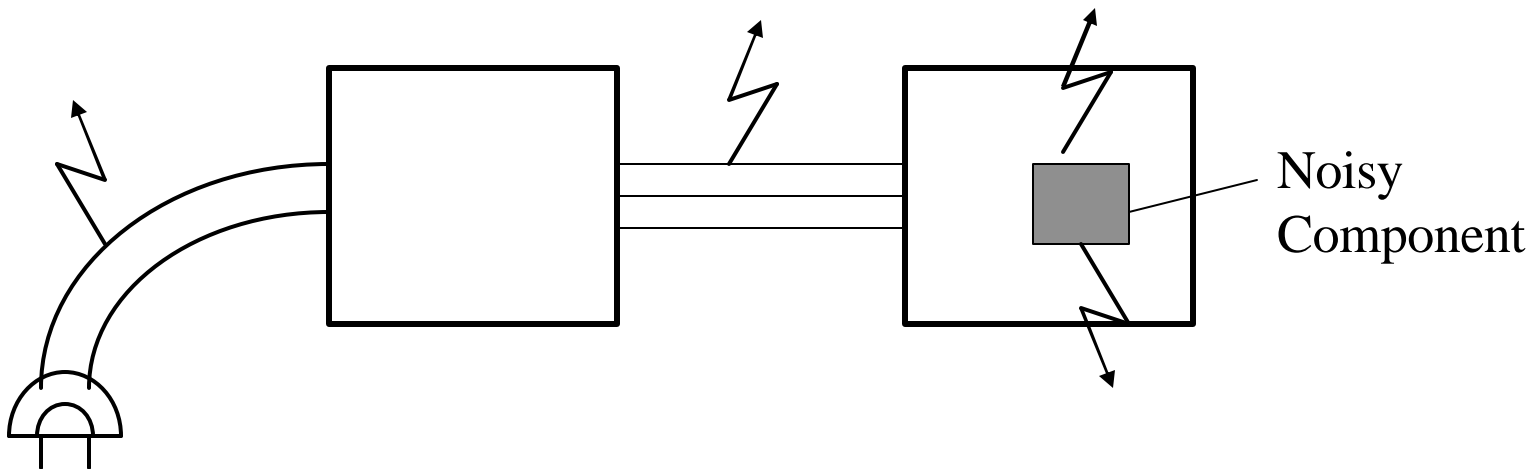
- Subject matter was referred to as EMI or RFI
- EMI is Electromagnetic Interference
- RFI is Radio Frequency Interference
- Design community created the term EMC to more positively refer to these conditions

# Composition of EMC



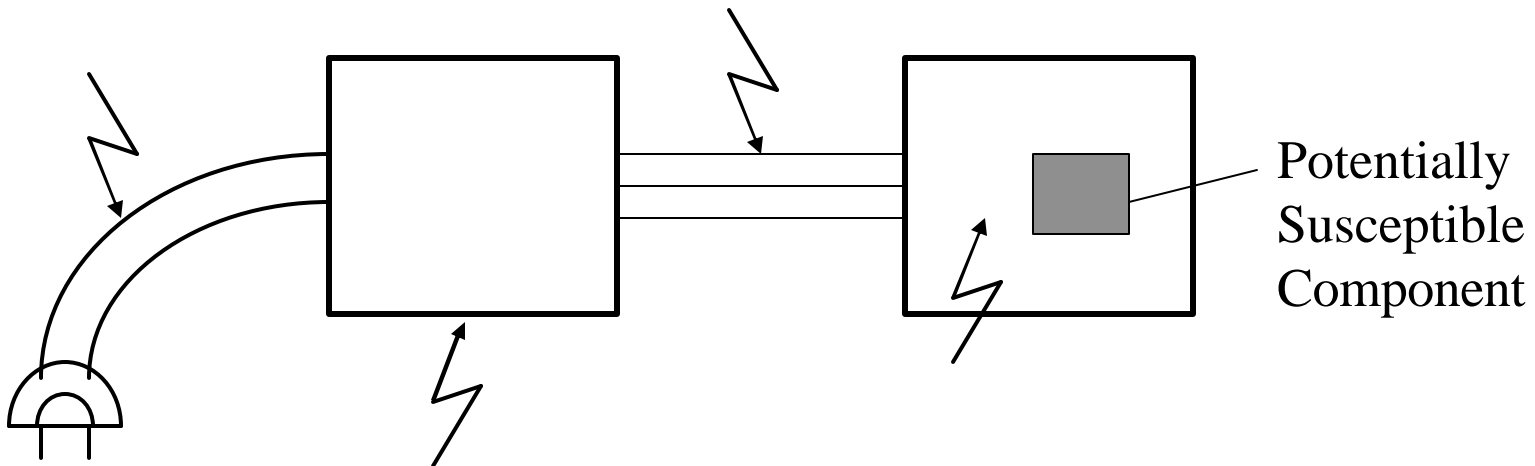
# Preventing Interference Subgroups

- Radiated Emissions



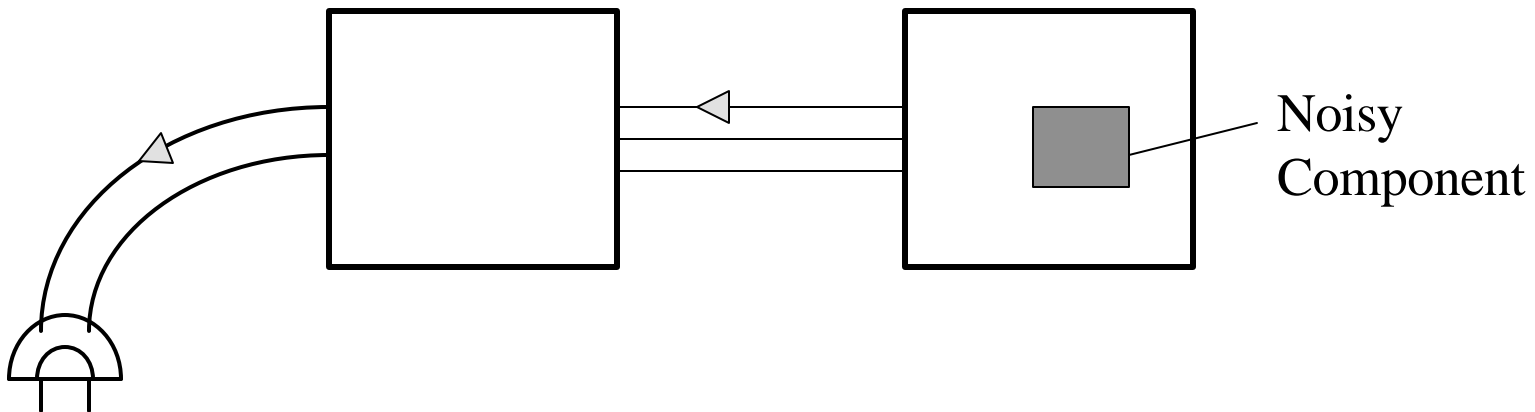
# Preventing Interference Subgroups

- Radiated Susceptibility (Immunity)



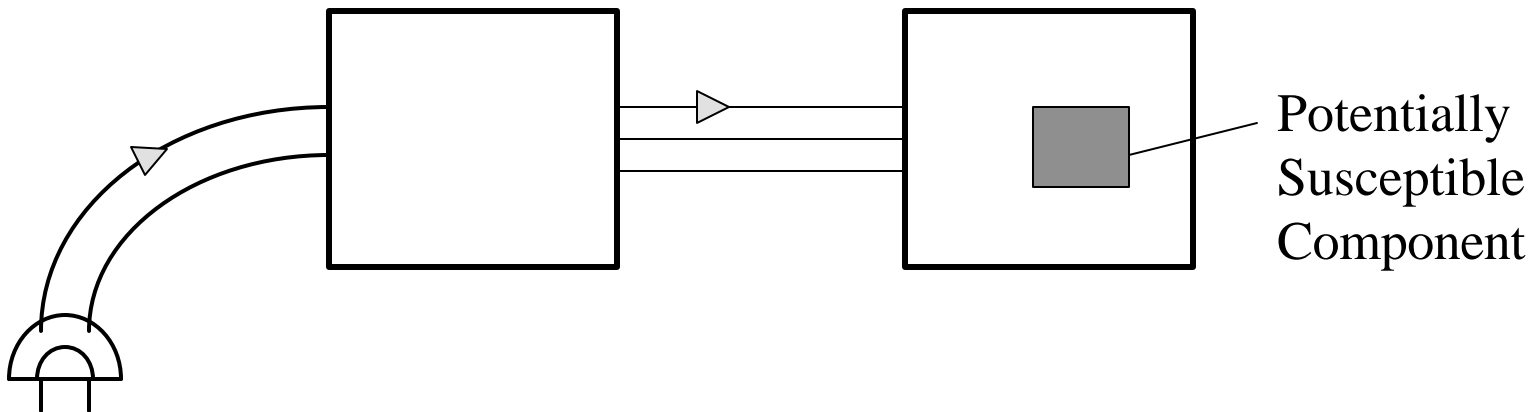
# Preventing Interference Subgroups

- Conducted Emissions



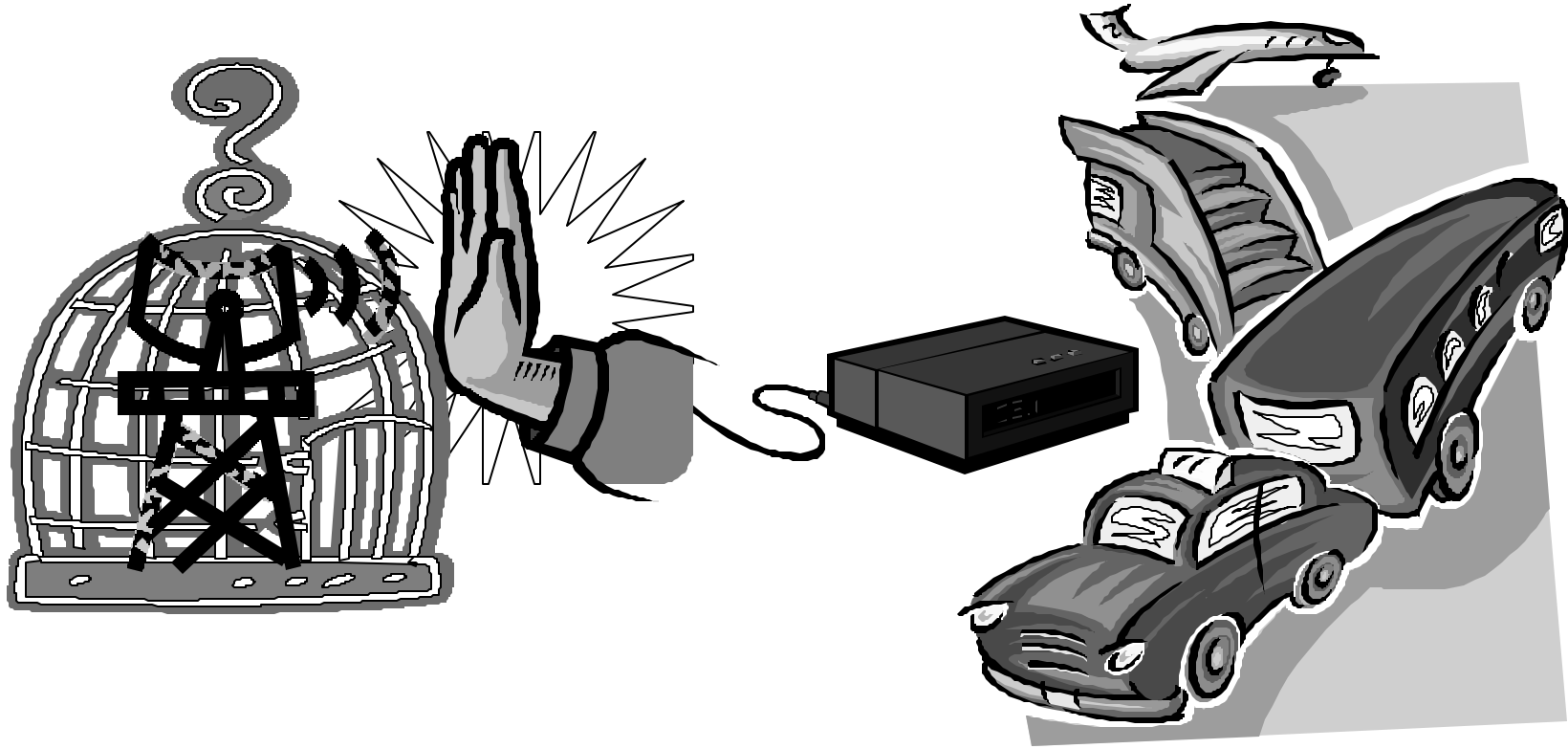
# Preventing Interference Subgroups

- Conducted Susceptibility (Immunity)



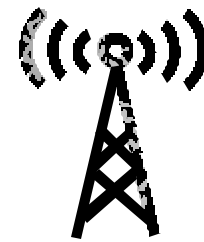
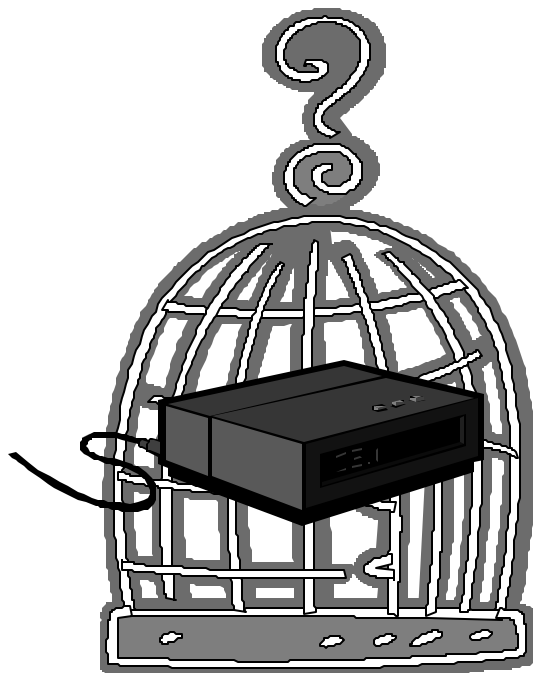
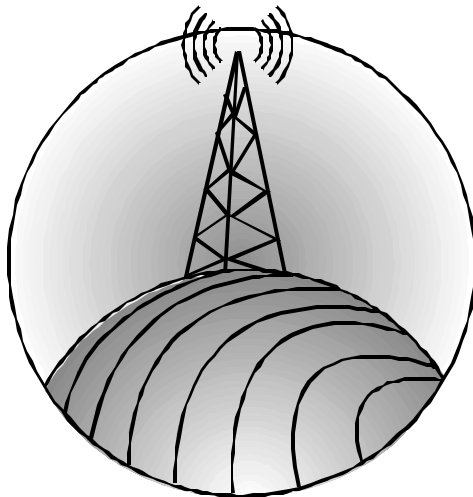
# Popular Instances of EMC

- Emissions
  - Protect nearby radio receivers.



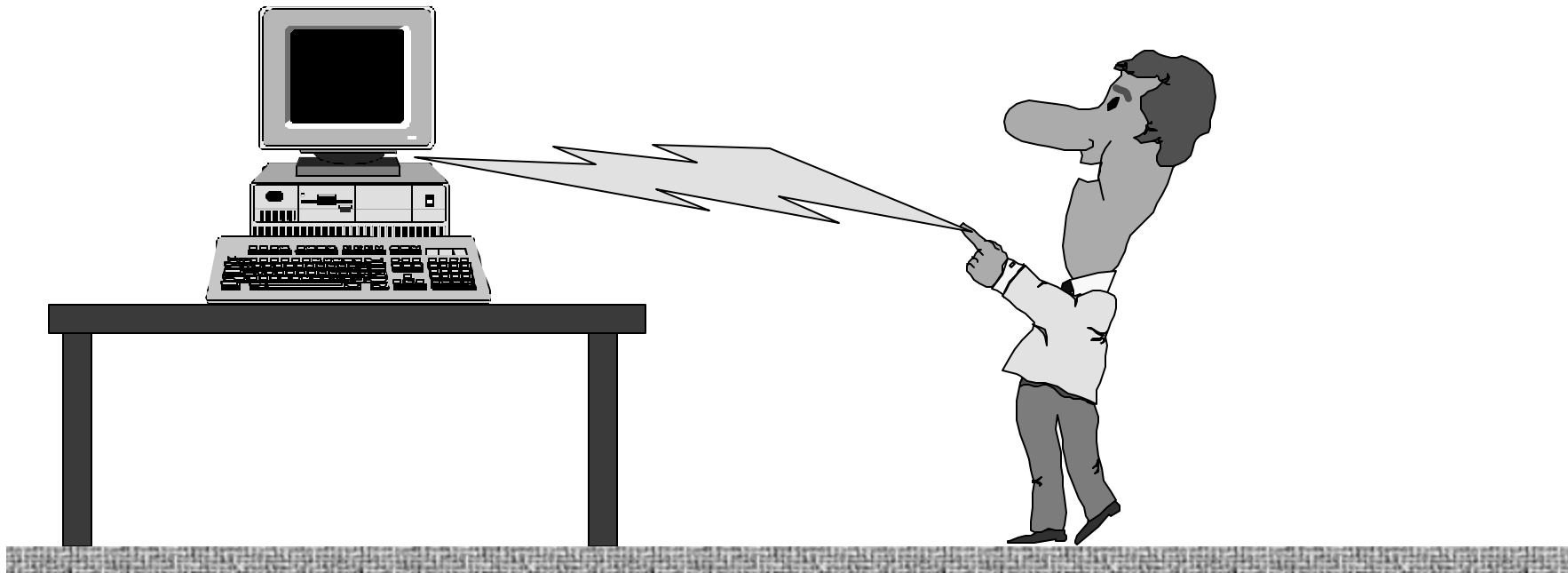
# Popular Instances of EMC

- Radio Frequency Interference
  - Protect against nearby radio transmitters.



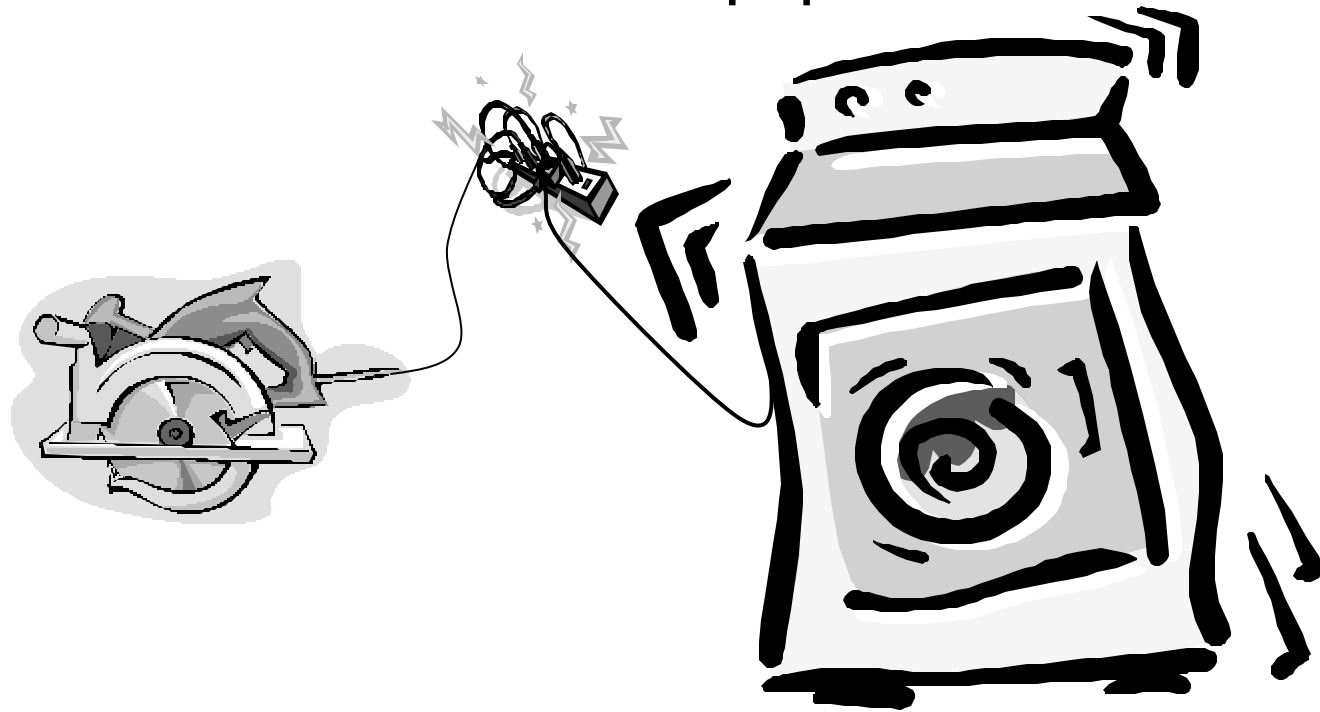
# Popular Instances of EMC

- ESD - Electrostatic Discharge
  - Transfer of static charge between the application and something else



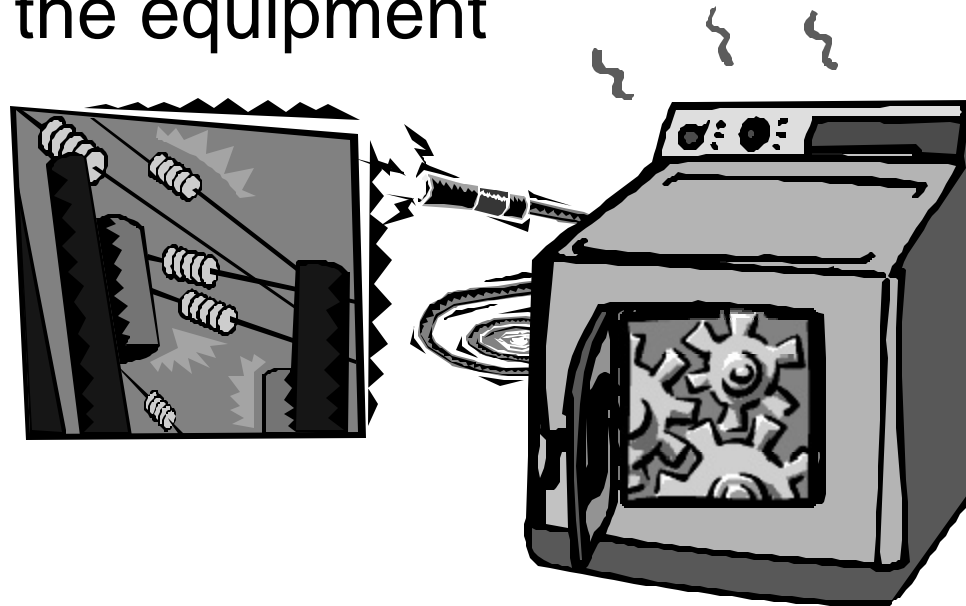
# Popular Instances of EMC

- EFT - Electrical Fast Transients (Power Disturbance)
  - Power Disturbance to equipment



# Popular Instances of EMC

- Flicker & Harmonics
  - Power Disturbance from equipment
  - Noise on power lines by inductive switching within the equipment



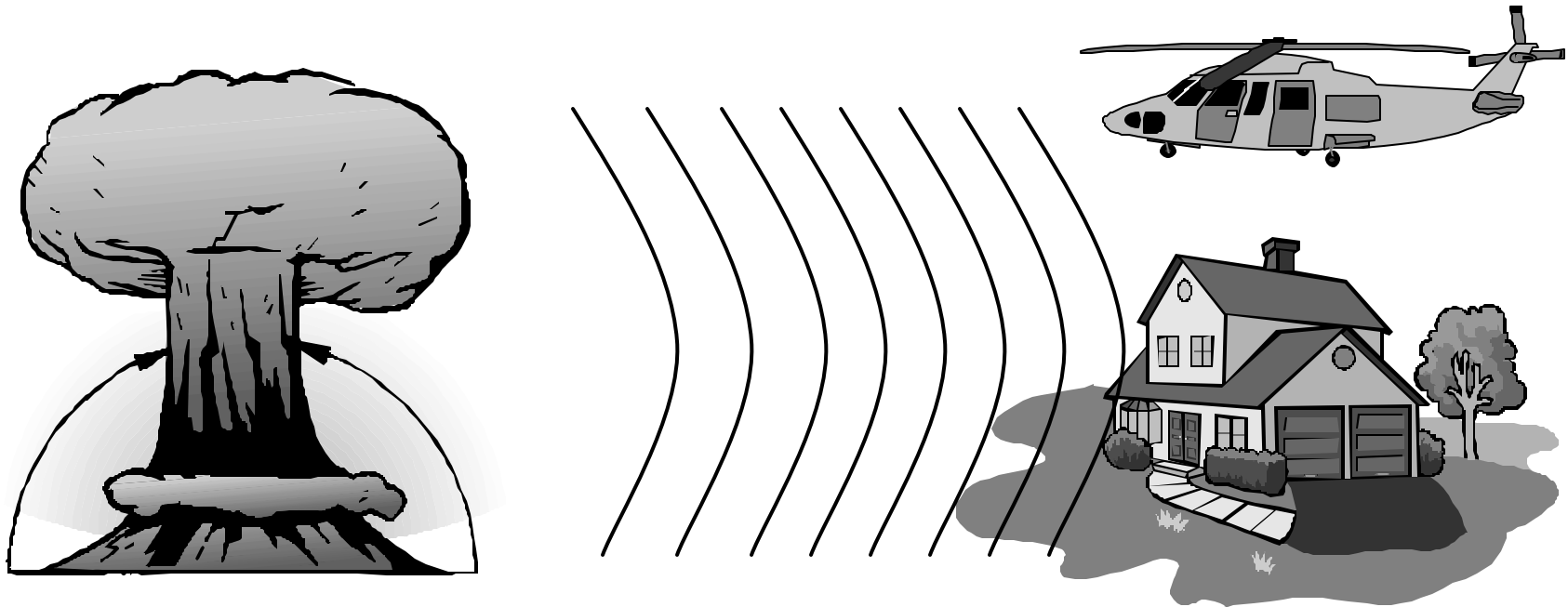
# Popular Instances of EMC

- Lightning
  - Indirect strike of lightning (Power “Surge”)



# Popular Instances of EMC

- EMP - Electromagnetic Pulse
  - Intense electromagnetic wave caused by a nuclear detonation



# Regulations

- FCC-Federal Communications Commission
- IEC - International Electrotechnical Commission
- Military
- Medical
- Vehicular
- Other

- Focus on emissions

Any unintentional radiator (device or system) that generates and uses timing pulses at a rate in excess of 9000 pulses (cycles) per second and uses digital techniques...

- Defines two classes

- Class A: marketed for use in commercial, industrial or business environments
- Class B: marketed for use in residential environment, but includes use in commercial industrial or business environments

# IEC

- International body that process regulations to facilitate trade between countries
- Regulations focus on both emissions and immunity
- Standards include the IEC 61000-x-x
- Also include CISPR standards
  - International Special Committee on Radio Interference includes CISPR 11, 22
- Two types of standards
  - Basic standard covers specific interference
  - Product standard covers specific products

# IEC Standards

- 60601 -> Medical electrical equipment
- 61000-3 -> Electromagnetic Compatibility
- 61000-4-2 -> ESD
- 61000-4-3 -> Radiated Electromagnetic Field
- 61000-4-4 -> EFT/Burst
- 61000-4-5 -> Surge
- 61000-4-6 -> RF Field Conducted Disturbances
- 61000-4-11 -> Voltage dips and interruptions

# IEC Standards CISPR

- 11 -> Industrial, Scientific and Medical (ISM) radio frequency equipment
- 14 -> Electromagnetic Compatibility - Requirements for household appliances, electric tools and similar apparatus
- 22 -> Information Technology Equipment (ITE)

# Military Standards

- Military standards focus on both emissions and susceptibility
- Includes electronic equipment used:
  - Submarines to outer space
  - desert to arctic environments
  - computers, control systems, radio communications
- Standards are application specific
- Standards can be negotiated
- MIL-STD-461E is key EMI specification

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# Telecom Standards

- Telecom standards focus on both emissions and susceptibility
- Includes telecommunication equipments
- BELLCORE GR1089 is a key specification

# Medical Standards

- Prime concern is reliable and safe operation of equipment
- Main focus on immunity to ESD, RF fields, and power disturbances
- Medical devices exempt from FCC in US
  - No mandatory EMI requirements
  - FDA recommends IEC 60601
- Europe uses IEC 60601
- Standards depend on application
- Current leakage based standards

# Vehicular Standards

- Among the toughest standards in the world
- Covers planes, trains and automobiles
- Electronics operate in extremely harsh conditions
- Also extremely cost sensitive
- Focus on immunity and emissions
- Society of Automotive Engineers publishes standards
  - SAE J551 and J1113

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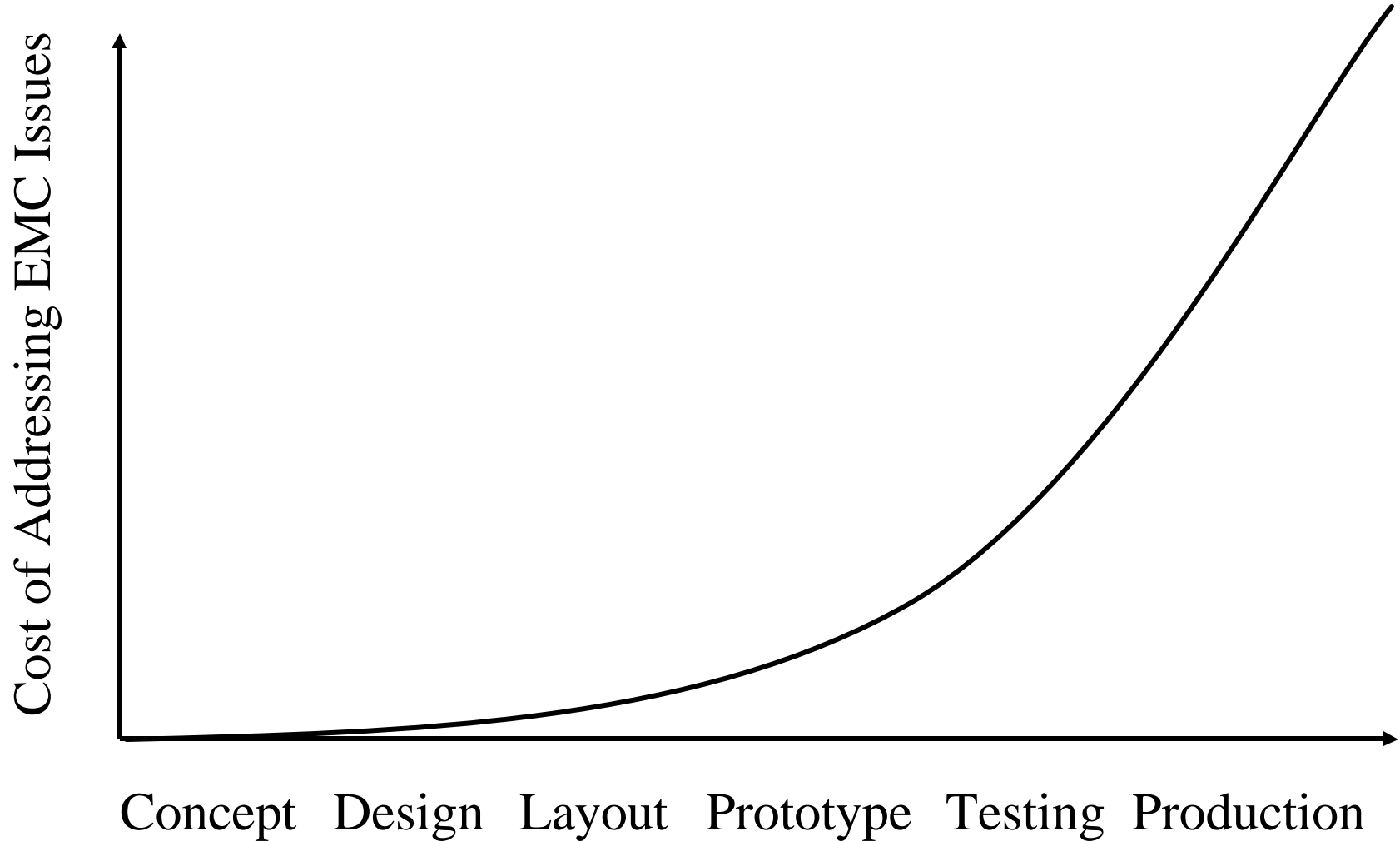
# Other Standards

- **ANSI/ESD-S20.20 -> Protection of Electrical and Electronic Parts, Assemblies and Equipment**

# No Standards!!!

- “Environmental Noise Effect”
  - Spark generator
  - Igniters
  - Arc welders
  - Large Motors
  - RF Heaters
  - Relays
  - Thyristor drives
- ‘Bad’ power conditions
- Switch Mode Power Supplies
- Transformerless power supplies

# Cost of Addressing EMC



# Objectives (Initial Seminars)

- Focus on EMC subgroups
  - “It is not susceptible to emissions from other systems”
    - Electrical Fast Transients (EFT)
    - Electro Static Discharge (ESD)
  - “It does not cause interference with itself”
    - Inductive Loads
    - Connectors/ Cables

# Objectives (Initial Seminars)

- Focus Applications
  - Cost Sensitive Applications (Single/ Two layer Printed Circuit Boards (PCB) )
  - Typical Application
    - Uses microcontroller and some digital glue logic
    - Uses some analog blocks
    - Does power control through Relays / Triacs
    - May use transformerless power supply

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# Objectives (Initial Seminars)

- Procedure
  - Explain fundamentals
  - Provide simple low cost Tips & Tricks for,
    - Schematic, component placement & PCB layout
    - Use cheap (mainly passive) components
    - Component selection

# What's coming?

- EMC overview
- EFT standard - IEC 61000-4-4
- ESD standard - IEC 61000-4-2
- Noise fundamentals
- Transformerless power supplies
- Component selection
- PCB layout fundamentals
- Tips & tricks, Tips & tricks, Tips & tricks.....
- Case Studies
- Etc, Etc.....